Increasing CHP productivity while reducing biosolids volume and climate changing gasses

Richard (Dick) York
Chief Technologist, FOG Energy Corporation
Retired Superintendent, City of Millbrae, WWTP

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Overview

- Definitions
- Describe the Millbrae POTW
- Relate the driving and convincing factors
- Relate reasons to choose grease
- Describe the system
- Discuss the results
- Summarize
- Questions

Definitions:

- Co-Generation:
  - The production of electricity using the heat byproduct for a beneficial purpose

- Distributed Power Generation:
  - The production of electricity where its use is intended

Understanding **the terminology**

- FOG: Acronym for “Fats, Oils, and Grease,” often interchanged with trap waste
- Yellow Grease: Deep fryer grease or oils
- Brown Grease: Grease found floating in a restaurant grease trap
- Black Grease: Grease congealed inside sewer pipes
- Trap Waste: Sewage (water and organics) and brown grease from a grease trap, often used synonymously with FOG
- IKG: Acronym for Inedible Kitchen Grease

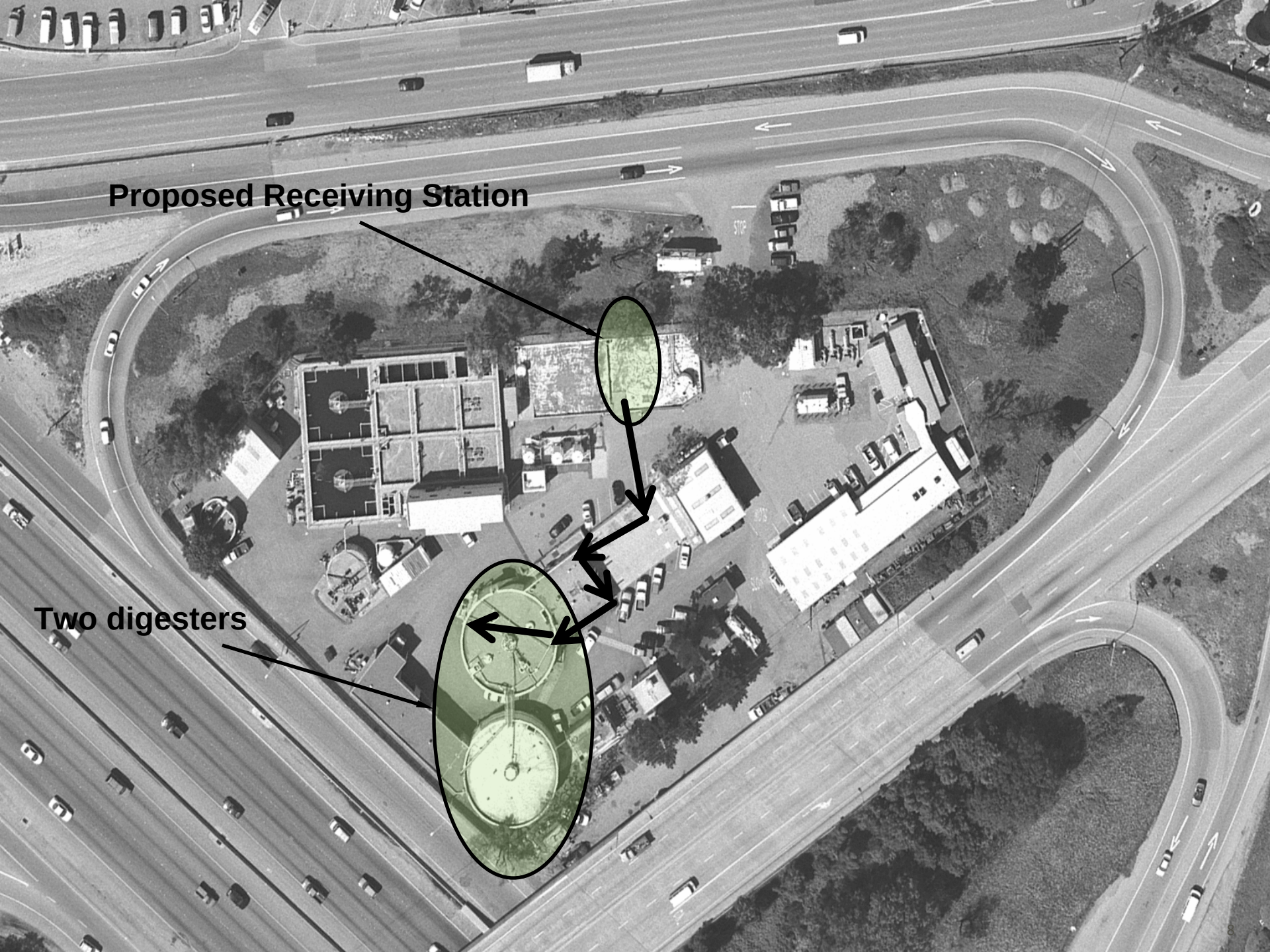
Millbrae, CA WWTP

Background on **the WWTP**

- Small and old
  - primary constructed in 1950
  - secondary in 1967
  - serves a population of ± 20 k
  - less than 5 acre
  - produces tertiary quality effluent
- 3 MGD capacity, 1.8 MGD annual flow
- Peak IWWF = 9 MGD; AWWF 6 MGD
- Facility is road locked
- Facility is shared with other PW crews

Driving Factors to Augment Digester Feed

- Treatment Plant didn't produce enough biogas to justify CHP equipment
  - Also couldn't continuously operate
  - Plenty of unused digester capacity
- Antiquated 20 year old ICE co-generator
  - Hard to get parts
  - Polluting
  - Extended down time
- Rising energy costs
  - No new utility generators
  - Price of fossil fuel
- Numerous POTW infrastructure needs…OLD


Proposed Receiving Station
Two digesters

Unique Attributes

- KNOWING
  - the system will enable you to identify and capture the unique attributes of your plant.
- Millbrae identified
  - Ample Digester Capacity (2 digesters)
  - Easy freeway ON – OFF (road locked)
  - Need for major renovation (old)

Millbrae POTW, 7/07

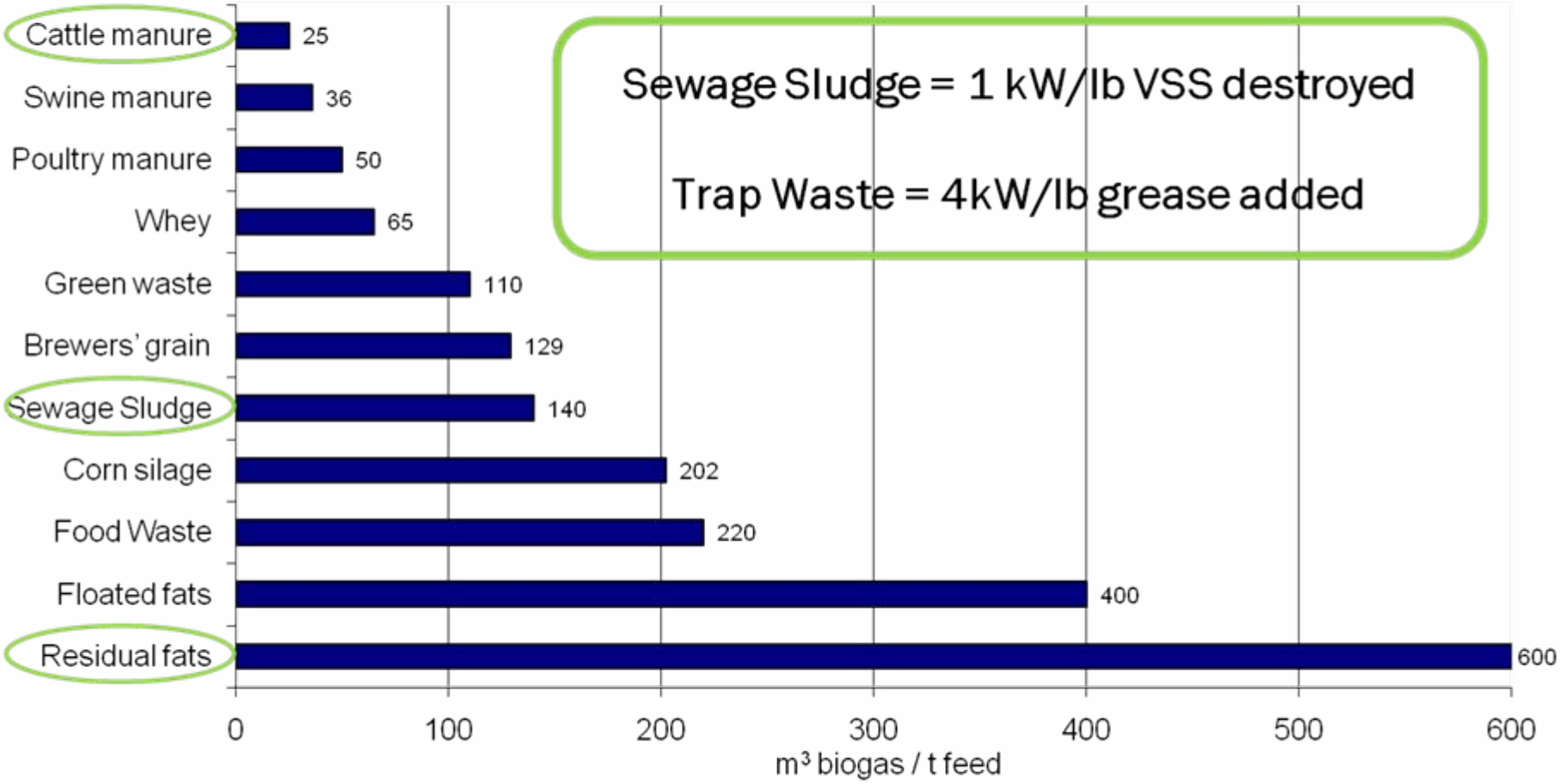
Project Scope: Equipment upgrades

- 55 year old boiler
  - (250 KBTU replaced with 1 MBTU)
- 34 year old stand-by diesel generator
  - (Compressed Natural Gas Storage system and Electrical Switchgear with “basic” island mode functionality)
- 25-55 year old switchgear
- 20 year old co-generator
- 20 year old gas digester mixing system
  - (essential for efficient production of methane from grease)
- 15 year old sludge circulation pump
- ***Added FOG Receiving and Processing System***

Why Consider Receiving Grease/FOG?

- IKG (brown grease / FOG) found in trap waste
  - Is readily available
  - Disposal problematic
  - Grease is easily digested if fed properly
  - High energy content
  - Consistent character
  - Environmentally responsible
- Improved project economics
  - Additional digester gas produced
  - Additional revenue from tipping fees
  - Reduced Biosolids

Feedstock Comparisons



■ Lusk, Philip D (2005). Establishing Credibility. PowerPoint presentation given at Fifth Annual BioCycle Conference on Renewable Energy From Organics Recycling, September 2005, Madison, Wisconsin.

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Common Fatty Acids

FATTY ACID	FORMULA	OCCURENCE
Acetic	CH_3COOH	Vinegar
Butyric	C_3H_7COOH	Butter
Caproic	$C_5H_{11}COOH$	Butter
Caprylic	$C_7H_{15}COOH$	Butter
Capric	$C_9H_{19}COOH$	Coconut oil, butter
Lauric	$C_{11}H_{23}COOH$	Spermaceti, coconut oil
Myristic	$C_{13}H_{27}COOH$	Nutmeg butter, coconut oil
Palmitic	$C_{15}H_{31}COOH$	Animal and vegetable fats
Stearic	$C_{17}H_{35}COOH$	Animal and vegetable fats
Arachidic	$C_{19}H_{39}COOH$	Peanut oil

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Convincing Factors

- 20 years CHP experience
- Innovative – well trained staff
- Ample digester volume
- Neighboring POTW were receiving grease
  - But had lots of problems

Problems with FOG and FOG Programs

- FOG
  - UBIQUITOUS
  - INSIDIOUS
- Problems Plagued Many FOG Receiving Programs
  - Clogs – downtime for receiving stations and plant
  - Odors
  - Grease balls
  - Digester Upset
  - Not hauler friendly
  - Low yields/digestion

Anaerobic Breakdown of Fats

- Breakdown is complex
- Different microorganisms
- Final reaction:

$$CH_3COOH \rightarrow CO_2 + CH_4$$

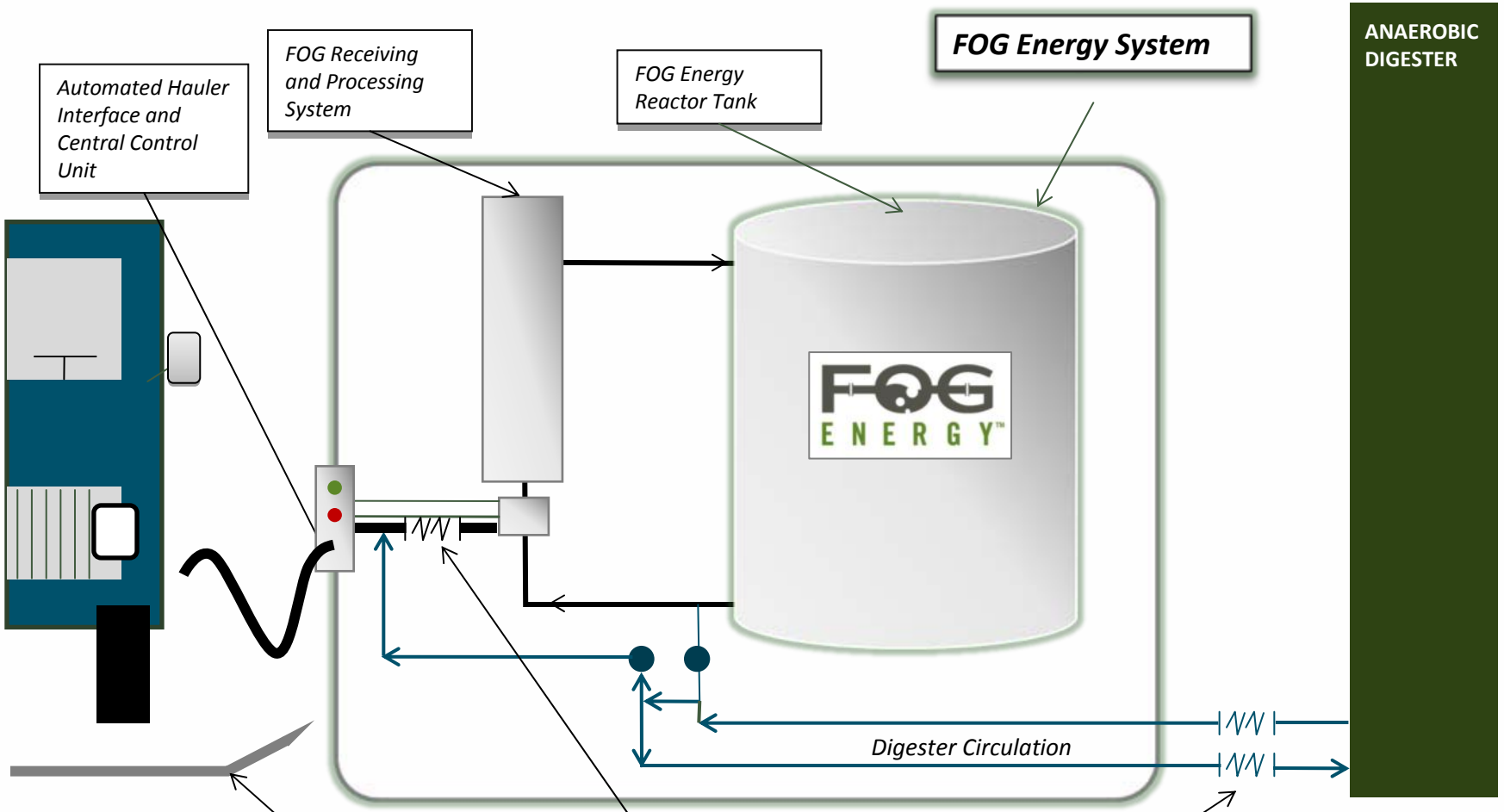
- A WW anaerobic environment ideal

BIOAVAILABILITY IS KEY

How did we boost bioavailability?

- **Automated Preconditioning**
  - Treatment begins immediately as FOG is off loaded.
  - FOG is combined with actively digesting sludge in a precise ratio.
- **'Bioreactor' Processing and Storage**
  - FOG-Sludge Mixture Blended into miscible, stable slurry.
  - Chemical composition is changed, surface area maximized.
  - **NO Separation, NO Clogs, NO Odors.**
- **Continuous metered introduction**

FOG Receiving System Design



Millbrae FOG Receiving Station

Microturbine

Some Grease Trap Production Rates

- National Avg. = 16 lbs / year / person*
  - 4.6 billion lbs / year
    - At 1 kW per pound added, that's equivalent to a generating about 4,600 GWh annually in the US alone (1 GW = 1 billion watts)
    - That's about 525 MW of new generating capacity
    - (Millbrae system has achieved 4 gross, netting 1.22 kW w/microturbine)
- Sacramento, CA Ave. = 11.2 lbs / year / person*
- Provo, UT Ave. = 26.6 lbs / year / person*

** Source: Wiltsee, G. "Expanding BioEnergy Partnerships." BioEnergy '98, 1998*

Benefits

- Facility improvements Generate more than $300,000 of benefit each year
  - *With no new costs to the ratepayer*
- New revenue: Tipping fees $0.06 / gal = $80,000 per year
- Utility savings = $204,600 per year
  - 1.1million kWh per year @ $0.186 / kWh
  - Last year, $0.165 / kWh, up @11%
  - System configured to serve as standby power during outages
  - Now only buying minimum required electricity from PG&E
- Increased biosolids destruction more than 25 %
- Reduced biosolids dewatering and disposal costs, saving 20-30% on disposal costs

Environmental Benefits

- Cleaner air
- Less GHG
- Renewable energy
- Reduced landfill disposal
- Less biosolids
- Local grease disposal facility
- No residual waste
- Less trucking
- No chemicals used
- **Huge benefits for small investment**

FROM
CLOGGED

To
Clean

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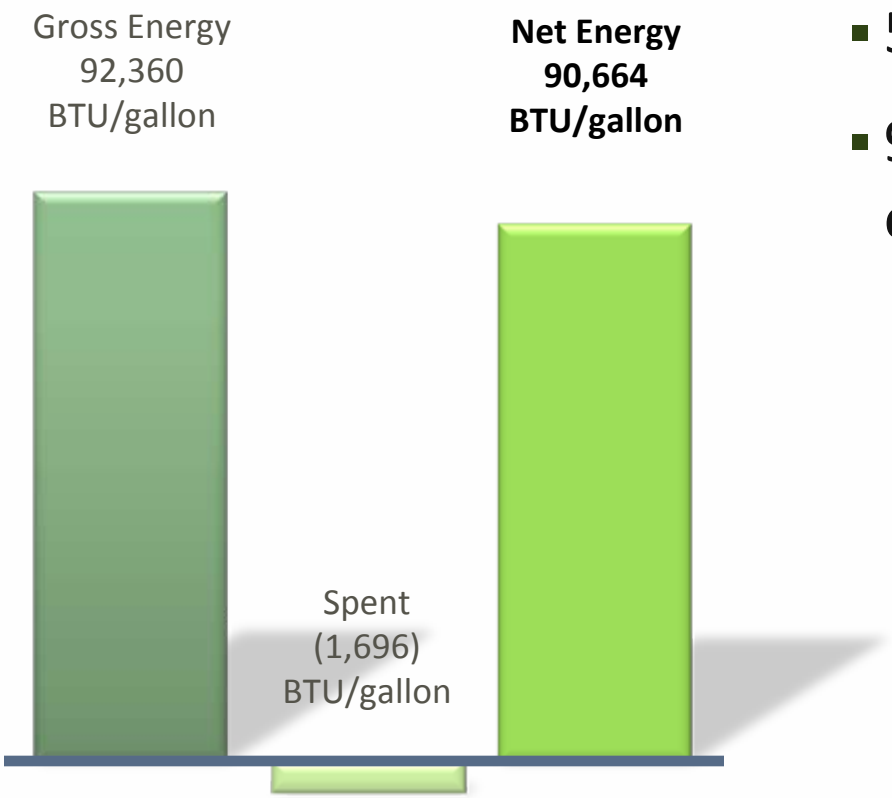
System Yield

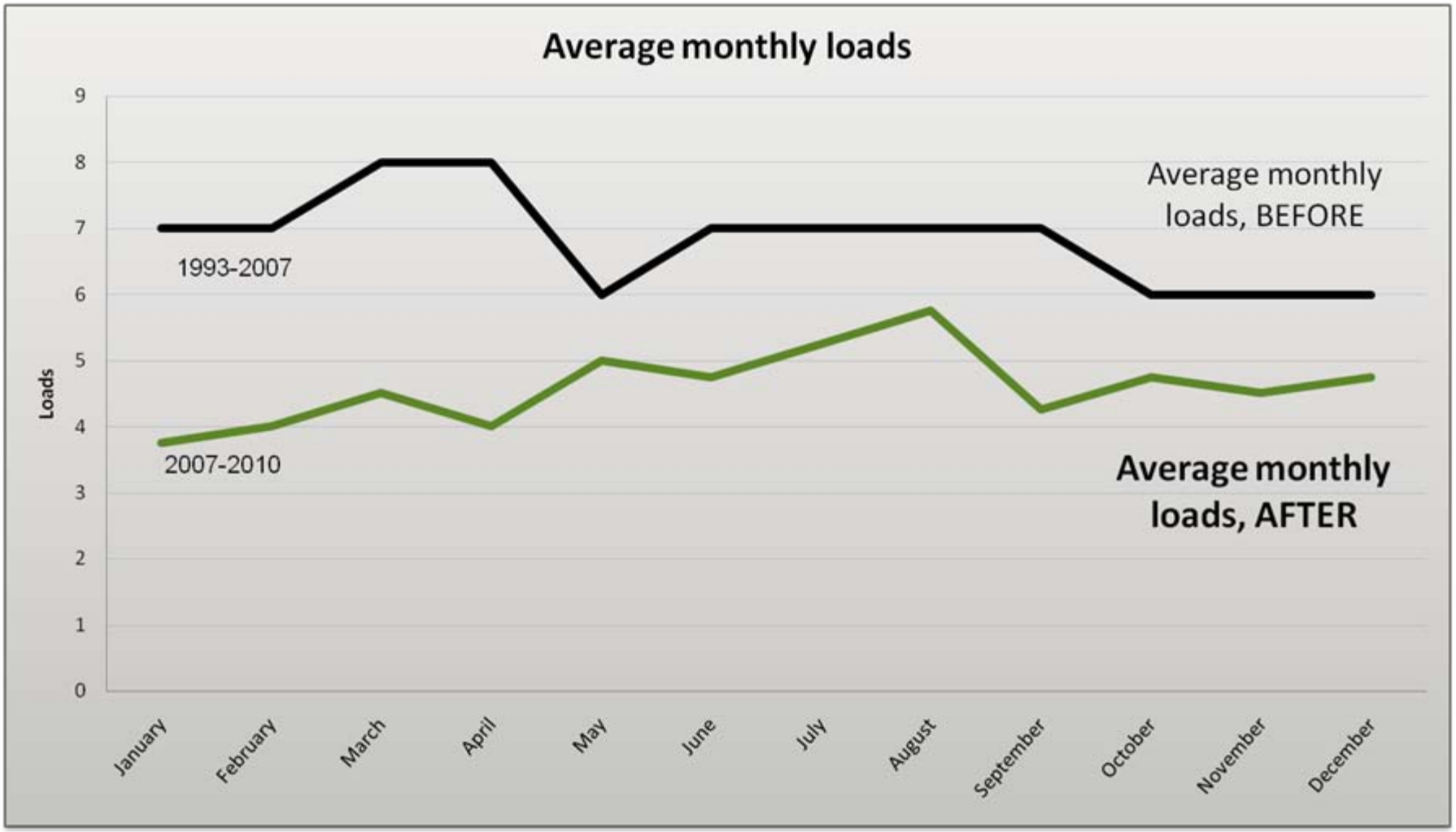


Actual FOG Energy Operating Performance

Note: Energy units are expressed as BTU per gallon of brown grease.

- 54X Energy Production Ratio
- 98% energy conversion efficiency
  - Energy used for powering pumps and system controls only

33% Fewer Biosolids Disposal Loads



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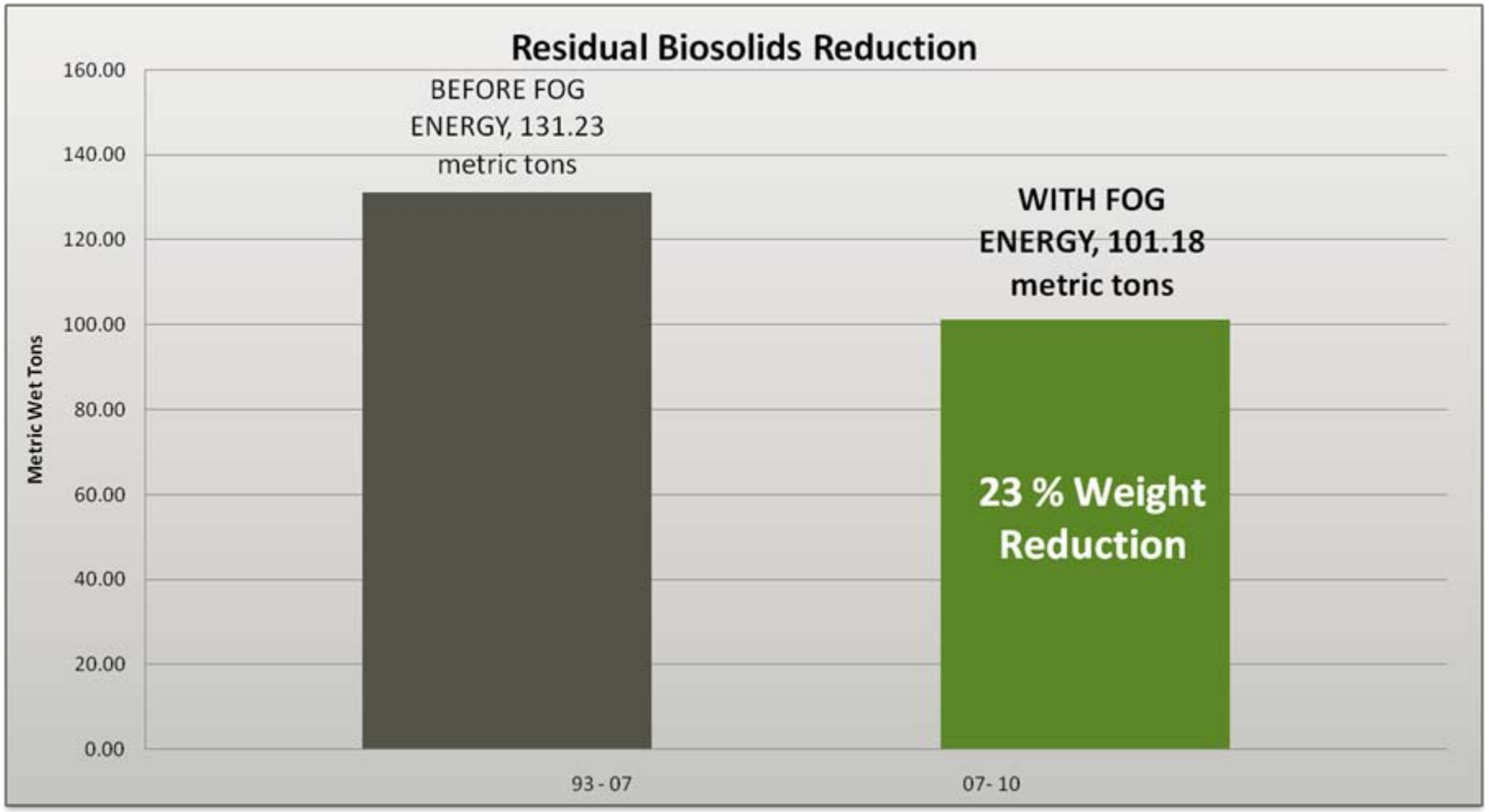
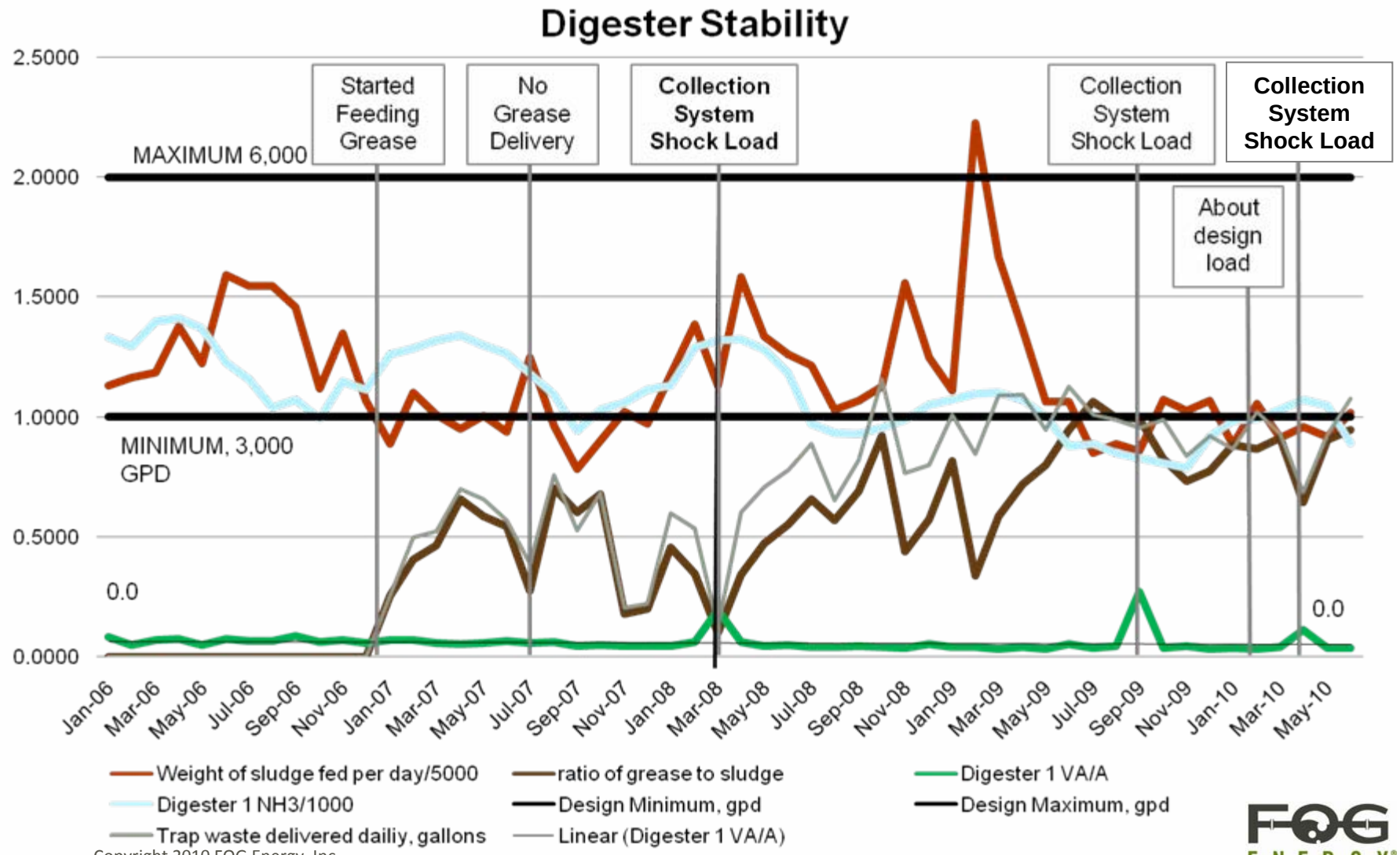
Reduced Biosolids by Weight



Digester Stability



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TAKE HOME MESSAGES!

- **BIOAVAILABILITY IS KEY TO MAXIMIZE YIELDS**
- PRE-PROCESSING ACHIEVES BIOAVAILABILTY
- FES is OPERATOR APPROVED
- NO DOWN SIDE IF DONE RIGHT

Summary

- Helps solve the FOG problem
- Encourages proper grease disposal
- Makes electricity from waste
- Benefits of reduced dewatering and biosolids
- Cleaner air
- Smooth operation
- Exceptional results
- **Saves money!!!**

QUESTIONS ???

- CONTACT INFORMATION:

Dick York

FOG Energy Corporation, CTO

E-mail: dick@FOGEnergycorp.com

www.fogenergycorp.com

405 Paine Road

Castle Rock, Washington, 98611


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